Scenario Making for the Dimensions Macro Environment based on Fuzzy Delphi Method (Case Study: Assembly Companies in the Power Industry)

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Abstract

Background/Objectives: The main purpose of this study is scenario planning for the macro environment of four assembly companies in power industry. **Methods/Statistical analysis:** In This research, to predict the dimensions of macro environment of the above four assembler companies, we used the scenario planning and PEST analysis. One of the necessities of this investigation is recognition of the environment about the industry which affects indirectly on industry and creates opportunities and threats for industry sectors. **Results:** In this study, at first we recognized the critical uncertainties using the Fuzzy Delphi Method. Then, by using the above results, we obtained the final scenarios which cover the major part of the future. The results show five scenarios formed using four critical uncertainties, the stability of government, the nuclear issue, monetary and exchange rate. Due to the experts opinions, in attention to the conditions prevailing in the country and agreements made, there is not any significant change in next three years and key uncertainties will continue as usual. Therefore, the third scenario as the most likely scenario is chosen. **Conclusion/Application:** The applied method in this article can be used to provide the necessary strategy for different companies and industries and introduce investment orientations for the intended industries.

Keywords: Assembly Companies, Fuzzy Delphi Method, Macro Environment, Power Industry, Scenario Planning

1. Introduction

The future of power industry faces many challenges and difficulties. At the present moment, it experiences a high rate of development but there are major challenges in such a dynamic environment. In such a situation, planning a scenario is conceived as the most proper long-term planning method for supporting decision making in unsecure condition¹.

The aim of present study is to answer this question that: What scenarios can be planned for the general environment of power industry? Scenarios are different stories of probable futures which a government, organization or entity might face. Scenarios led to the focus of organizations on the diversion points of the future and potential consequences of different future plans of action. Managers are better provided for future insecurities based on projected future decisions and testing suggested strategies in different conditions.

In such a case, made-up decisions will have a higher flexibility against majority of future events even though some of them might be unexpected. Application of fuzzy Delphi method in order to make decisions and to provide consensus on issues the aims and parameters of which are

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extremely uncertain is proper to its significant characteristics which covers most of difficulties associated with lack of precision and specificity. Due to the fact that attaining consensus based on the viewpoints of experts is among the characteristics of Delphi method, fuzzy Delphi is applied as a medium of alignment of existing viewpoints.

In the present study, PEST analysis (political, economic, social and technological conditions) was applied for prediction of general environment of four assembly companies. In this regard, expert views of eight specialists of this industry would contribute in providing the intended scenarios. The ideas of these experts where collected through questionnaire and they were asked to revise their views in each period based on temporary analysis and then the final Delphi data is used for organizing scenarios and TOPSIS technique is applied for their prioritization.

2. Literature Review

Implementation of scenario planning in a business environment is a new and relatively comprehensive issue². In scenario planning, the existing information and facts of natural sciences, sociology, economics, etc. are applied for provision of some logical and integrated stories of the future world are issued which are called scenarios. There are three methods for application of scenario planning which include: expert method, partnership method and organizational method. The simplest method is expert method in which one individual or a small number of individuals take the responsibility of doing a process³. Major part of scenario planning are alternative thinking, enhancement of planner's understanding and provision of a structure for dealing with uncertainty⁴.

Varum and Melo⁵ examined the orientation of scenario planning in the past few decades and found out that only in one electronic data center (ISI), before 2006, 194 essays are concerned about scientific studies on scenario planning is different sections such as business, management, economy, management research and operation, development planning and social sciences so that about 70 percent of the essays are since 2000. Valsh⁶ used the scenario planning in developing a strategy and said that application of diverse scenarios can help an organization to deal with uncertainty and fierce environmental challenges. His approach consists of analysis of external environment and extraction of environmental scenarios as well as analysis of internal environment and examination of internal scenarios.

Scenario recognition means conception of multiple probable futures. As Martelli⁷ believed, planning based on a scenario is a management technology which is applied by managers for elaboration of their mindset models and better decisions. In different categorizations of scenarios, moral and communicative aspects are common and writers and those concerned with this issue base their classifications on their approach to decision making and latent scenario actions. For example Maleska and his team of colleagues in economy college of Turku introduced three types of mission, subject and action scenarios. Two different kinds of actions scenarios were also introduced including "forward-looking" and "backward-looking" scenarios⁸.

Based on these studies, one can conclude that the rate of application of scenario planning has a direct association with increase of unpredictability of business environment in diverse companies. Such studies show that majority of scenario users were big companies with high investment such as petroleum companies, car companies, and power and transportation industries. This issue can be justified by the fact that big companies are the ones with necessary resources and motivation for experimenting new planning methods.

Fuzzy Delphi technique is for development of a scenario based on expert's ideas. Delphi periods in developing evaluation is up to 2016 in small setting and structure of power industry.

3. Methodology

The focus of scenario development in the present study id on the general setting of industry. PEST analysis is applied for examination of future status of power panel assembly industry²⁶. In present study, the following question is analyzed: what scenarios are there in aspects of general setting of power industry (with analysis of fuzzy Delphi)? We based our study on a multi-stage process suggested by Bood and Postma²⁷.

Development of scenarios based on Delphi method is a theory which has been evidently suggested by other authors because Delphi process can be easily merged in the process of scenario development and provision of valid, trustworthy and valuable data for generation of scenario Delphi method aims to systematically develop a

Author(s) (year)	Focus	Horizon in years	Details of Present Study
Rajesh and Sanjay ⁹	Application	18	Prediction of power demand: In the present study, three scenarios called normal business, energy protection and renewable energies were introduced.
Elliston et al. ¹⁰	Methodology	20	Prediction of power costs: Three scenarios were provided based on minimum cost.
Rachmatullah et al. ¹¹	Application	15	Long-term demand planning: If in the present study, the suggested method is applied properly, scenario planning can lead to 3.5 billion dollars in a period of 15 years.
Bergman et al. ¹²	Methodology		Scenario process is used as a medium for evaluation of changing business setting and identification of necessary capabilities and suggestions for the company.
Soontornrangson et al. ¹³	Application	15	Application of scenario planning for reduction of power generation costs up to 3000 million dollars in a planning period of 15 years.
Bazilian ¹⁴	Application	18	The aim of present study is to provide the public access to modern energy services in Africa till 2030 in addition to attention the different power section
Mcpherson and Karney ¹⁵	Methodology		In the present study, investigation of future scenarios is done based on marginal cost system, global warming and indexes of resource diversity.
Park et al. ¹⁶	Application	42	The essay on energy analyzes the environment and economy based on scenarios of power industry for 2050 and uses planning system for energy substitution.
Chen et al. ¹⁷	Application - Methodology	15	A scenario for the next 15 years is formed based on the scenario of convention of stable energy policy and scenario of new energy policy.
Feng and Ryan ¹⁸	Methodology	20	Heuristic test should be used for planning in development of long- term power generation. In the present method, cluster mode was used for the first time.
Ackerman and Fisher ¹⁹	Methodology		In the present study, four scenarios were developed: lack of new limitation, limitation of Carbon diffusion, limitation of water consumption and mixture of Carbon and water limitations
Dagher and Ruble ²⁰	Methodology		The present study is concerned with modeling probable paths for the future of Lebanon power status and its evaluation. The obstacles of predicting the energy composition from common energy sources to renewable energy sources are provided.

Table 1. Most relevant results of literature review on scenario planning in power industry

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	r	r	r
Ozer et al. ²¹	Application	24	An analysis based on long-term scenario of planning system of energy substitution in energy sector of Turkey.
Li et al. ²²	Application	10	This essay is an analysis of different cases for allocation of proper power system in China of 2020.
Elliston et al. ²³	Application	20	Genetic algorithm and simulation medium are applied for identification of minimum costs.
Dyner and Larsen ²⁴	Methodology		Description of setting in monopoly condition followed by modification of rules based on fundamental hypotheses
Loostma et al. ²⁵	Application - Methodology		Prediction of basic power demands for evaluation of development of national economy.



Figure 1. Process of scenario development.

consensus among experts' ideas regarding future changes and formulated events in predictions, for example future short theses. In present method, prediction is reflection of group viewpoint^{28–30}

Figure (1) shows the steps of present study and how Delphi method is used for development of scenario. First, we develop a set of indexes based on the general environment of industry. Then, experts of power-panel assembly industry were identified, evaluated and selected for involvement in Delphi survey. Thirdly, indexes were evaluated by experts and then analyses of temporary view points of the group as well as interpretation of total calculations are done. Fifthly, experts revise the answers of the first period based on feedback and temporary analysis. Sixthly, fuzzy Delphi data was used for development of scenario. In the present study, two Delphi periods were applied so that the second period consists of revision and reconsideration of answers of the first period. In the first period, experts usually provide their ideas in vocal variables and then, the average of experts' ideas (provided values) and difference of viewpoint of each individual from the mean is calculated followed by forwarding information to experts for obtaining new ideas. In the next step, each expert uses the information of preceding

Political Factors	Economic Factors	Social Factors	Technological Factors
Government Stability	GDP Rate	Unemployment Rate	Product Life Cycle
Political Relationship with Neighboring Countries Rate of Bank Interest		Level of Education	Level of Intellectual Property
Nuclear Issue of Iran	Level of Savings	General Approach to Job and Activity	Technology Life Cycle
Government support	Rate of Currency	Investment Culture	Speed of Technology Transfer and Obtainment
State Budget	Rate of Inflation	Global Economic Crisis	Access to International Technology
Monetary Policy	Direct Cost	Facilitation of Global Business Laws	Quality of Produced Power Panel s
Financial Policy	Overhead Costs	Internal Competitors of Power Panel Industry	Developing Power Panel Industry
Value-added Policy	Per-capita Income	External Competitors of Power Panel Industry	
State Budget in R&D	Distribution of Income		
Custom Rate of Importing Foreign Ingredients	Price of Oil		

Table 2. Indexes for 2016

step to provide new ideas or to revise previous ideas³¹. Majority of researchers believe that a highly significant value is obtained after the first repetition^{32,33}. The answers are finally analyzed and applied for developing a scenario. The next steps include secondary study, composing scenario, analysis and final examinations for match-up by an expert.

4. Developing Indexes

A set of indexes for better understanding is provided. Delphi study consists of predictions for the future of Power-panel industry till 2016. (Table 2)

Because indexes are added and evaluated during temporary analysis, the final list consists of 35 items. The inputs are developed from four sources for provision of indexes (Table 3). Application of many sources for developing indexes forms the basis of our study. Table 3.Content generation for development ofprojections

No.	Content generation phase
1	Survey among top futurists
2	Interviews with scenario experts
3	Desk research of existing scenario studies
4	Database with future factors

5. Selection of Experts

This stage consists of getting together of a group of expert and important individuals and sufficient understanding of power-panel industry such as those who are interested in suggested subject as well as commitment to the process. In order to obtain such objective, a list of experts and specialists was provided including those with associated educational degree (at least B.A in Electrical Engineering) and job experience (10 years at least). Improper selection of experts has the highest disruptive effect on Delphi validity³⁴. In the present study, the authors applied a three-stage method including potential experts, evaluation of identified experts and using such experts.

The initial investigation included 15 experts among members of management boards of four major powerpanel assembly companies in Iran. Each one of chosen companies had a turnover of about 300 thousand dollars in a year. For each one of candidate experts, a value for presentation of individual expertise was defined. Values were based on a set of variables including level of management, scientific basis, expertise, national and foreign organizational performance and age^{28,35,36}.

In each one of the companies, experts of highest value were invited. If an expert was not inclined to participate in present study, the next expert of highest score was invited. In sum, 8 experts of 4 assembly companies accepted to participate in present Delphi study. Among these individuals, two persons (25 percent) were among management board while 4 persons were development and strategy experts in their own companies. In two cases (25 percent), invited individuals gave up their participation advantage to a proper organization member. These were sales and marketing experts. All participating experts had 10 years' experience in power-panel industry.

	percent	number	degree
	25	2	PhD
	62/5	5	MA
= PhD	12/5	1	B.A
M.A B.A	100	8	tota1

Figure 2. Degree of experts.





6. Evaluation of Indexes and Temporary Analysis

In this level, the main objective is to identify four or five factors, at most, based on highest significance and the least uncertainty. In the first Delphi period, experts evaluated each index based on its significance and level of certainty for 2015. The levels of significance and certainty were measured in a five-point Likert scale. After the first period, the authors did temporary analysis based on descriptive statistics (i.e. mean and standard deviation). The interpretations were provided through content analysis.

7. Evaluation of Indexes in Second Delphi Period

Based on temporary analysis, the second evaluation period initiated in which each expert had the opportunity for revision of answers of the first period. In fact, all experts that participated in the second period had a high level of satisfaction of content and design of questionnaire. It is logical to suppose a high level of satisfaction of existing commitment and involvement the result of which is apparent in enhancement of quality of poll data.

8. Developing a Scenario

Based on predicted evaluation results of experts, the authors identified the scenarios of future of power-panel industry for 2015 which included thunder, turbulence, raining, stability and sunny scenarios. General descriptions of probable scenarios are based on experts' viewpoints during Delphi periods and secondary study. Probable scenarios are provided in the fourth chapter. Events and news can be defined as weak probability but they have a high effect upon decision making in industry or corporation domains. One of the experts will examine the scenarios by qualitative variables.

In this stage, provided scenarios are tested and answering the issued questions defines the index of each scenario including cases such as strength, integrity and realism. In other words, this stage will question the supposed prospect based on the significance of power industry in the proposed scenario and necessary infrastructure is formulated for defining different strategies. So, the primary aspects of scenarios are formulated based on influential key aspects and analysis of experts' ideas.

9. Results

Delphi Results

In this level, the information of questionnaire which are associated with significance and certainty of influential key factors are collected and integrated. The information output of applying fuzzy Delphi method in the questionnaire is fuzzy numbers. In this level, the results are converted to non-fuzzy values (Table 4) and defining the points in Cartesian graph (level of significance, level of certainty) critical uncertainties are defined.

In a Cartesian plot, the vertical axis is associated with level of certainty while the horizontal axis is associated with level of significance. Accomplishment of this stage lead to placement of factors of the first (government stability), third (resumption of nuclear issue of Iran), sixth (monetary policy) and 14 (currency rate) in critical area. These factors are in level of significance of higher than 7 and level of certainty of less than 7.

10. Probable Future Scenario

The probable scenarios are created through defining the critical uncertainty of probable scenarios. Doing this lead to finding the measured certainties by experts in different scenarios. In order to do this task, different cases of critical uncertainties are defined and primary scenarios are built based on different cases. This level is followed by testing scenarios and deletion of scenarios which are improbable or of paradoxical internal factors. Then, each one of remaining scenarios was distinctly examined and the resulting scenarios are the final ones.

Despite the fact the provided scenarios are formed based on primary uncertainty (government stability) but the close association between the first and second uncertainties forms the major part of the final scenarios so that if nuclear agreement is terminated, application of stable policies seems relatively improper and in such a setting, significant reduction of currency value and expansionary monetary policy seems improbable. This is while attaining agreement on nuclear issues or attempt to do that creates the setting for stable policies and execution of different kinds of monetary policies.

dne			level of significance		level of certainty		Critical
Gro	Nun	Influential key factors	average	deviation	average	deviation	uncertainties
	1	Government Stability	9,1113	1,0184	6,4033	1,503	*
	2	Political Relationship with Neighboring Countries	7,2725	1,5508	7,5313	2,5005	
	3	Nuclear Issue of Iran	9,0303	1,0013	6,5856	3,5056	*
	4	Government support	5,5776	3,5025	7,5556	1,503	
ical	5	State Budget	6,5513	1,5026	7,4356	1,5041	
Polit	6	Monetary Policy	8,904	2,0184	6,1303	2,0126	*
	7	Financial Policy	5,357	1,5203	5,882	2,0104	
	8	Value-added Policy	4,9336	3,0021	6,9633	2,001	
	9	State Budget in R&D	5,0286	3,5939	6,802	2,0291	
10	Custom Rate of Importing Foreign Ingredients	7,5573	1,5032	7,5906	2,5049		
	11	GDP Rate	7,0413	2,0012	7,1886	3,0336	
	12	Rate of Bank Interest	6,6	2,5059	6,5106	2,5005	
	13	Level of Savings	6,906	2,0066	6,3526	2,5791	
	14	Rate of Currency	8,6843	2,0033	6,843	2,0452	*
omic	15	Rate of Inflation	8,4753	1,5006	7,301	1,5041	
Econ	16	Direct Cost	8,495	1,0564	7,5353	1,5012	
	17	Overhead Costs	7,5666	2,5026	7,9973	2,0104	
	18	Per-capita Income	6,3403	1,5252	5,979	2,001	
	19	Distribution of Income	6,1946	2,5553	6,299	2,0291	
	20	Price of Oil	7,16	3,0127	7,938	2,5049	

Table 4. Determine the results of the non-fuzzy obtain	ned from the experts
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	21	Unemployment Rate	4,9333	2,0033	6,392	1,5116	
22 23	22	Level of Education	6,059	2,6140	6,417	3,5029	
	23	General Approach to Job and Activity	5,5933	3,0815	6,9013	2,0072	
Ir	24	Investment Culture	6,7473	3,0317	7,8226	2,0234	
Socia	25	Global Economic Crisis	6,7626	2,541	6,759	1,5656	
	26	Facilitation of Global Business Laws	7,843	2,0184	7,1166	2,5866	
	27	Internal Competitors of Power Panel Industry	7,1966	1,0564	7,6333	1,5176	
	28	External Competitors of Power Panel Industry	5,882	2,0104	6,416	3,0034	
	29	Product Life Cycle	7,5936	1,5087	7,5313	3,0336	
	30	Level of Intellectual Property	6,5066	2,614	6,7706	2,039	
al	31	Technology Life Cycle	7,3993	3,0815	7,695	2,0276	
nologic	32	Speed of Technology Transfer and Obtainment	7,3953	3,0317	7,968	3,0005	
Tecl	33	Access to International Technology	7,0473	2,541	7,99	2,6514	
	34	Quality of Produced Power Panel s	5,512	2,5	5,3846	3,5056	
	35	Developing Power Panel Industry	7,1853	2,0255	7,134	2,5791	



Figure 4. Comparison of projection and elements of a probable scenario.

Table 5.	Final Scenarios
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Number of Scenario	Government Stability	Nuclear Issue of Iran	Monetary Policy	Rate of Currency	Name of Scenario
1	Consistent State Policy Changes	Fortification of Sanctions and International Pressures	Contractive	Increase	Thunder
2	Consistent State Policy Changes	Resumption of Current Status and Follow-up of Nuclear Agreement with Iran	Expansionary	No Significant Change	Turbulence
3	Consistent State Policy Changes	Resumption of Existing State and Follow-up of Nuclear Agreement	Expansionary	No Significant Change	Raining
4	Stability of Short- term State Policies	Resumption of Existing Status and Follow-up of Nuclear Agreement	Expansionary	No Significant Change	Stability
5	Stability of Long- term State Policies	Removal of Sanctions and Solving Nuclear Issues	Expansionary	Reduction	Sunny

11. Selection of Final Scenarios

Final scenarios cover a significant and influential part of probable future which means that all possible future cases are not covered. This fact is very important in selection of final scenarios because the attempt to cover all possible future cases would make the deletion of some scenarios an impossible task.

In the following, description of each scenario is provided:

1) Thunder: in this scenario, the conditions are changed into the worst possible case. Increase of sanctions and international pressures creases a setting of international crisis so that it demands conception of some solutions and application of proper mechanism by the state necessitating execution of new policies. Modification of policies would lead to fundamental cuts and strong contractive policies. High-tension global setting and changes of political status in the region and international scale would create strong deviations in currency rate and its ultimate increase.

2) Turbulence: In this scenario, just like Thunder, intensification of sanctions and international pressures would occur but, unlike Thunder scenario, the global status will remain away from global crisis due to inability to deal with them. In such a situation, the necessary solutions are provided and consistent modification of policies occurs so as to minimize the consequences and to better

manage the existing condition. Expansionary and contractive policies are alluded to as proper solutions and there would be no significant change in currency rate.

3) Raining Scenario: In this scenario, the existing trend is towards resumption of nuclear agreement and striving to create mutual trust and to execute mutual policies so that continuous cycle of finding new solutions and emergence of new difficulties demands proper state actions which challenges stable and long-term policies in short-term. In such a setting, diverse pressures will emerge either temporarily or in a more enduring manner so that neutralizing them would raise consequences and damages. In such a condition, monetary policies would be followed in a continuous and proper manner and there would be no significant change in currency rate.

4) Stability Scenario: In this scenario, the condition would remain relatively stable. Despite continuation of negotiations and nuclear agreement, relative national stability is created and the resulting conception necessitates following short-term policies. In such a condition, only events such as cancelling the agreement with passing a new verdict or similar cases would cause change of situation as well as apparently new and stable trends. In such a condition, expansionary policies are applicable through execution of necessary techniques and currency rate would have no significant change just like the previous scenario.

Priority	Scenario
1	Stability
2	Turbulence
3	Rainy
4	Thunder
5	sunny

Table 6. Priority scenarios

5) Sunny Scenario: In such a scenario, the reality of peaceful nuclear power of Iran from the west is followed by generation of necessary setting for complete execution of permanent and long-term policy. Solution of nuclear issue of Iran and elimination of sanctions necessitates orientation towards total economic freedom. Removal of limitations provides the essential industrial setting for using all potentials and without any previous considerations. Implementation of expansionary policies acts as the best option for monetary policies and the currency rate would have a decrease in such a condition.

These scenarios are finally integrated and TOPSIS method is used for prioritization.

Based on provided prioritization, the experts of power panel industry have focused on stability and turbulence scenarios more than other ones.

12. Conclusion and Concepts

Our objective in the present study is to define the scenarios of aspects of general condition of four assembly companies in power industry. The main question of present study is: What scenarios are there for aspects of general environment of power industry (through fuzzy Delphi analysis)? The answer to this question was defined by using the questionnaire of defining key uncertainties for which the ideas of eight experts were analyzed through fuzzy Delphi method and conversion of results into nonfuzzy values would lead to finding four factors of highest significance and lowest uncertainty, namely government stability, Iran's nuclear issue, monetary policy and rate of currency. At first, different cases of uncertainty are defined and based on diverse compositional cases, zero scenarios are created. Then, logical relationship among critical uncertainties contribute to removal of improbable scenarios and in the final stage, among the existing scenarios, four to six scenarios were chosen to cover a major portion of probable future.

The applied method in this article can be used to provides the necessary strategy for different companies and industries and introduce investment orientations for the intended industries. One can also use other prioritization methods for selection of final scenarios. The defined scenarios in the present study can be a primary reference for short and medium-term strategic planning in this industry. Any kind of study would face limitations among which the following ones exist for the present study: weakness of research and survey culture in national industry, lack of cooperation in provision of company information, difficult access to managers, managers' disinclination to use the results of different studies and to collect information through reporter panes and workshop method.

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